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INVESTOR IN PEOPLE

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South Wales
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The Patent Office

Cardiff Road
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1. Your reference

XLT 92

2. Patent application number
(The Patent Office will fill in this part)

0315666.8

4 JUL 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

HEAD PHILIP
GIBB HOUSE
KENNEL RIDE
ASCOT
BERKS
SL5 7NT

Patents ADP number *(if you know it)*

79208120001

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

4. Title of the invention

METHOD OF DEPLOYING AND POWERING AN ELECTRICALLY DRIVEN DEVICE IN A WELL

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

HILLGATE PATENT SERVICES

NO. 6 AZTEC ROW
BERNERS ROAD
LONDON
N1 0PW

Patents ADP number *(if you know it)*

59531|2002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
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No

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	—
Description	11
Claim(s)	—
Abstract	—
Drawing(s)	2

10. If you are also filing any of the following, state how many against each item.

Priority documents	—
Translations of priority documents	—
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	—
Request for preliminary examination and search *(Patents Form 9/77)*	—
Request for substantive examination *(Patents Form 10/77)*	—
Any other documents *(please specify)*	—

11. I/We request the grant of a patent on the basis of this application.

Signature Hillgate Patent Service Date 4/7/03

12. Name and daytime telephone number of person to contact in the United Kingdom PAUL HARMAN 020 7704 9997

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METHOD OF DEPLOYING AND POWERING AN ELECTRICALLY DRIVEN DEVICE IN A WELL

FIELD OF THE INVENTION

This invention relates to a method of deploying an electrical submersible powered fluid transducer system, such as a gas compressor or an electrical submersible pump, generally known as an ESP, in an oil and/or gas production well.

BACKGROUND OF THE INVENTION

The disposing in wells of electrical submersible systems has been done for many years using jointed tubular conduits with an electrical motor, and a fluid transducer connected to the bottom of the jointed tubing. Consecutive joints of tubular conduits are connected and lowered into a well with the assistance of a rig mast and hoisting equipment, whilst unspooling and connecting to the outer diameter of the tubing a continuous length of electrical power transmission cable. This method of disposing the electrical submersible fluid transducer system is well know to those familiar with the art of producing non-eruptive sources of oil and gas from the subterranean environment. The retrieval of these electrical submersible fluid transducer systems is also commonly accomplished by pulling the jointed tubing out of the well simultaneously with the electrical submersible motor and fluid transducer system and the electrical power transmission cable. The following prior art references are believed to be pertinent to the invention claimed in the present application: U.S. Pat. Nos. 3,939,705; 4,105,279; 4,494,602; 4,589,717; 5,180,140; 5,746,582 and 5871,051; International patent application No. WO98122692 and European patent specifications

Nos. 470576 and 745176. U.S. Pat. Nos. 3,835,929, 5,180,140 and 5,191,173 teach the art of deploying and retrieving an electrical submersible system in oil wells using coiled or continuous tubing. These coiled tubing disposal methods often use large coiled tubing spool diameters owing to the radius of curvature possible of the continuous tubing. Hence the surface spooling devices that these systems require to inject and retrieve the continuous tubing are cumbersome, and require special surface and subterranean equipment for deployment and intervention.

Other previous art disclosed in the literature teaches the disposal and retrieval of the subterranean electrical fluid transducer system with wireline or wire rope as structural support for simultaneously disposing the electrical power transmission cable with the system. Hence these wireline methods and apparatus involve the use of large and unique surface intervention equipment to handle the weight and spool used for the electrical power cable and the wire rope to be run in the well. U.S. Pat. No. 5,746,582 discloses the retrieval of a submersible pumps whilst leaving an electrical motor and cable in a well. Hence the method of U.S. Pat. No. 5,746,582 teaches the retrieval and deployment of the mechanical portion of an electrical submersible fluid transmission system whilst leaving the electrical motor and other component parts of the electrical submersible system disposed in the disposal of the electrical motor separately from the electrical power transmission cable. In the case of artificially lifted wells powered with electrical submersible motor systems, the current art is to dispose the required transducer assembly, for example a pump or compressor assembly, with an electrical motor and electrical power cable simultaneously into the well with a supporting member. This supporting member is jointed tubing from a surface rig, a coiled tubing unit with continues tubing or braided cable. The tubing or a braided cable is required as the electrical power cable

is not able to support its own weight in the well and hence must be connected and disposed in the well with a structural member for support. In the case of jointed pipe deployed from a rig, the power cable is attached to the electrical motor on surface, and the cable is attached to the tubing as the electrical motor, transducer, and tubing are disposed into the well casing or tubing. The attachment of the cable to the tube is done by the use of steel bands, cast clamps, and other methods known to those familiar with the oil and gas business. In other methods, the power cable is placed inside of continuous tubing or attached to the outside of continuous tubing with bands as taught by U.S. Pat. No. 5,191,173. This continuous tubing is often referred to in the industry as coiled tubing. U.S. Pat. No. 3,835,929 teaches the use of the continuous tubing with the electrical power transmission cable inside of the tube. In all cases where electrical submersible fluid transducers systems are disposed and retrieved from wells the electric motor and electrical power transmission cable are deployed or retrieved simultaneously.

It is well known to those familiar with electrical submersible power cable that the action of removing the cable from the well can result in damage to the electrical power transmission cable, in a variety of ways. The damage inflicted on the electrical power cable can be due to bending stresses imposed on the cable during the disposal and retrieval. The conventional electrical power cable insulation, wrapping, and shields can develop stress cracks from the spooling of the cable over sheaves and spools devices used to deploy the cable. Another failure mode associated with submersible power transmission cable is caused form impact loads or crushing of the cable as it is disposed or retrieved in the wells. It is also well known that gases found in subterranean environments impregnated the permeability of the electrical power transmission cable's insulation, wrapping and shields.

This gas is trapped in the permeability of the insulation at a pressure similar to the pressure found inside the well. When the cable is retrieved from the well the electrically powered transmission cable is exposed to ambient pressures. This will create a pressure differential between gas encapsulated in the cable insulation and the ambient surface pressure conditions. The rate of impregnated gas expansion from the higher pressure inside of the cable insulation expanding towards the lower pressure of the ambient conditions can sometimes exceed the cable insulation permeability's ability to equalise the pressure differential. The result is a void, or stressing of the insulation, and premature failure of the cable. The requirement to retrieve and dispose the electrical power transmission cable with the electrical submersible fluid traducer system also requires the use of specialised surface intervention equipment. This can require very large rigs, capable of pulling tubing, electrical power transmission cable, and electrical submersible fluid transducers. In the offshore environment these well intervention methods require semi-submersible drill ships and platforms. In the case of jointed conduit deployed in a plurality of threaded lengths, normally 9-12 m each, the pulling equipment is a drilling or pulling rig at surface. In the case that the electrical power transmission cable and assembly are disposed connected to or in continuous tubing, a specialised coiled tubing rig is required at surface. This coiled tubing unit consisting of an injector head, a hydraulic power unit, and a large diameter spooling device containing the continuous coiled tubing all located on the surface. This disposal and retrieval method requires significant space at the earth's surface or sea floor. The reasons for intervening in a well to retrieve or dispose an electrical submersible transducer system are well know to those familiar with the art of fluid removing fluids from wells. There are at least two classical reasons for intervention in wells disposed with electrical submersible fluid transducer systems. These include the need to increase

fluid production, or the need to repair the disposed electrical submersible power system. The reason for requiring increased fluid production is dependent on many factors including but not limited to economical and reservoir management techniques discussed in the literature. The reasons for intervening for repair or to replace the electrical submersible fluid transducer systems are due to normal equipment wear and the subsequent loss of fluid production capacity, catastrophic equipment failure, and changes in the fluid production capacity of the subterranean fluid reservoir. The equipment failures can be caused due to subterranean electrical failures in the electrical motor windings, electrical motor insulation degradation due to heat or mechanical wear, conductive fluid leaking into the motor, wear or failure of the fluid transducer parts, wear of electrical motor bearings, shaft vibrations, changes in inflow performance of the reservoir, and other phenomena known to those familiar with the art of fluid production from wells. Therefore, it is often required to change out component parts of the electrical submersible fluid transducer system, but not necessarily the electrical power transmission cable. However, owing to prior art the power cable is retrieved when the electrical motor or the motor seals fail.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a system for installing a powered device in a downhole tube, comprising a power line disposed along a production tube, terminating in a first power connector, an orientation means disposed in the vicinity of the first power connector, and a powered device including a second power connector, the powered device being lowered down the production tube and oriented by the orientation means so that the first power connector means and second power connector means engage to connect the powered device to the power line.

Preferably the first power connector is supported by an alignment means that moves the first power connector from a first unaligned position to a second aligned position as the power connector descends towards it so that the first power connector means and second power connector means engage to connect the powered device to the power line.

According to another aspect of the present invention, there is provided a system for installing a powered device in a downhole tube, comprising a power line disposed along a production tube, terminating in a first power connector, the powered device being lowered down the production tube, the first power connector being supported by an alignment means that moves the first power connector from a first unaligned position to a second aligned position as the power connector descends towards it so that the first power connector means and second power connector means engage to connect the powered device to the power line.

The aligned position may be closer to the centre of the bore than the unaligned position.

Preferably a sleeve is provided with a cammed surface of which is shaped to orient the powered device. The sleeve ideally includes a keyway to move the first connection means towards the centre of the bore.

The method according to the invention comprises: connecting an electrical power cable to a first part of a wet mateable electrical power connector which is secured to a lower region of a production tubing; lowering the production tubing and the electrical power cable into the well; lowering through the production tubing an electrically driven downhole fluid

transducer system which is equipped with a second part of a wet mateable electrical power connector; releasably latching the transducer system to the production tubing such that the two parts of the wet mateable power connector face each other; Lowering of the electrical submersible fluid transducer system would be any number of means the most practical being a slickline or wireline conveyed system. If the device is in a deviated well then an electrically powered tractor could be used.

The current invention is an improvement to the known art of well construction, this invention teaches operational methods and claims apparatus related to disposing, operating, and retrieving electrical submersible fluid transducers systems. More particularly, the invention's methods and apparatus enables the electrical power transmission cable to remain in the well whilst teaching a plurality of retrieving and/or disposing well interventions for components of the electrical submersible fluid transmission system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates how the production tubing, electrical power cable, side pocket electrical connection are installed permanently in an oil or gas well.

FIG. 2 shows a side view of the electrical side pocket, with the electrical wet connect in the retracted mode.

FIG. 3 shows a side view of the electrical side pocket, with the electrical wet connect in the deployed mode.

FIG. 4 shows a plan view of the electrical side pocket, with the electrical wet connect in the retracted mode.

FIG. 5 shows a plan view of the electrical side pocket, with the electrical wet connect in the deployed mode.

FIG. 6 shows a side view of the well, with a pump being deployed inside the tubing and engaging a locating profile built into the side pocket electrical connect

FIG. 7 shows a side view of the well, with a pump being deployed inside the tubing and engaged and orientated into a locating profile built into the side pocket electrical connect

FIG. 8 shows a side view of the well, with a pump being deployed inside the tubing and sliding a sleeve to deploy the electrical wet connects built into the side pocket electrical connect

FIG. 9 shows a side view of the well, with a pump being deployed inside the tubing and landed with the electrical wet connects mated and the slick line deployment system disengaged.

DETAILED DESCRIPTION

Figure 1 shows production tubing 1, with two side pocket electrical connection housings 2 located in it. Oil flows from a lower zone 3, via the tubing to surface 4.

Figures 2-5 show the side packet electrical connection tool in more detail, In the example shown, it consists of 3 wet electrical connections 10 housed in such a way as not to obstruct the main bore when not in use. Provision of three connectors allows power to be supplied in convenient three-phase form. The electrical wet connects 10 are mounted on a saddle 11. The saddle includes lugs which engage a keyway mechanism 53 built into a sliding sleeve 13. The sleeve will ideally include an internal surface shaped to accommodate the saddle at its most radially outward position and allow it to move as described below without interference. The lugs on the saddle may be shaped to keep the wet connects upright.

Suitable power cabling 52 is disposed in the annulus between the borehole and the production tubing, secured to the outer surface of the production tubing. This cabling enters the side pocket unit through a port 54 before being separated into three connection cables 12. On the upper surface of the sliding sleeve is a orientation profile 14 which is shaped to ensure the component docking into it is oriented at the correct angle. Only after the docking component is correctly orientated will the saddle 11 be moved into the main bore.

Figure 6-9 show the sequence of operation when the through tubing deployed electrical device reaches the side pocket electrical connection.

The device 21 being deployed is lowered through the production tubing on a wireline 41. As the deployed device contacts the sleeve, extendible dogs 50 in the lowermost part of the deployed tool locate on the profile 14 and orient the assembly 21 to the required angle as the deployed device is lowered. As shown in figure 7, once oriented, the dogs push the sliding sleeve downwards. The male electrical wet connects 10 are both

constrained in the keyway 53 whilst also being held approximately level with respect to the side pocket and production tubing, for example by including an element cables 12 which is sufficiently stiff. The keyway is at an angle to the axis of the production tubing, so that as the sleeve descends relative to the production tubing, the male electrical wet connects are constrained to move towards the centre of the main bore (as illustrated in figures 3 and 5), so that male electrical wet connects 10 are aligned with the female half 23 of the wet connect provided on the deployed device. In its fully landed position 25 the wet electrical connections 10, 23 are fully engaged and the load of the deployed system is fully supported by the landing sleeve. At this time the deployment system 30 can be disengaged and recovered to surface as shown in figure 9.

One example of a deployed device which could suitably be installed in this way is a pump. After the male wet connects 10 and the female wet connects 23 are engaged, the pump can be turned on and fluid pumped to surface. It will be realised though that other assemblies requiring power can be installed using the principles disclosed herein.

In the above embodiment, the deployed device is provided with two dogs 50 which follow the upper surface of the sleeve as the pump descends, orienting the pump. It will be realised that other equivalent configurations are possible, such as providing the device with a single dog, and using a sleeve whose upper surface has a helically descending surface subtending 360°, the top and bottom of the helix being joined by a vertical step. The shaped orienting surface could be included on the bottom of the device.

Should the deployed device only be required temporarily, the deployment process may be reversed. The sleeve may include some resilient member,

such as a spring, so that the sleeve is maintained in its uppermost position, and the male wet connectors 10 retained away from the centre of the bore, when no powered device is installed. The principles included herein could alternative or additionally supply hydraulic power.

5

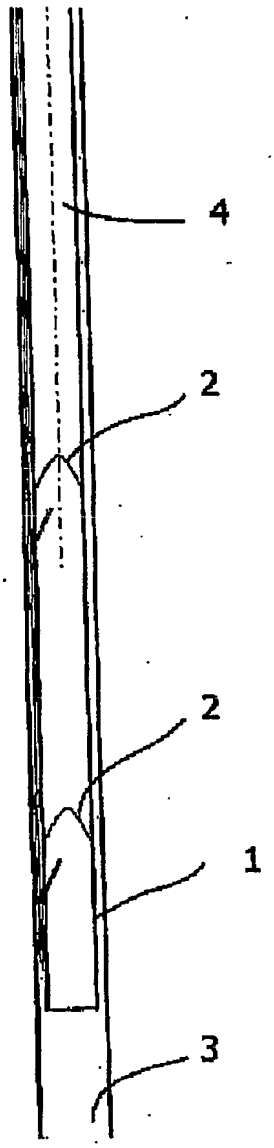


fig 1

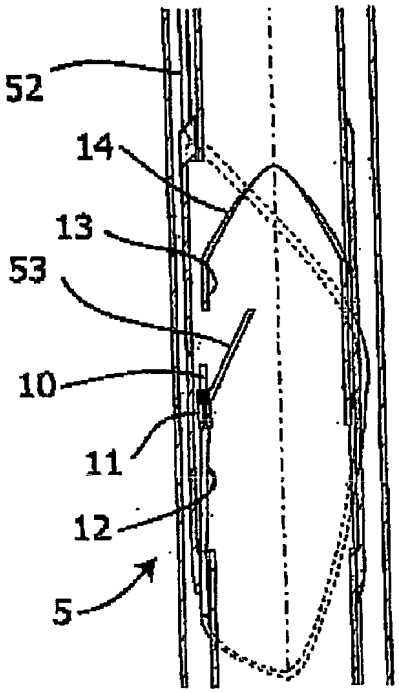
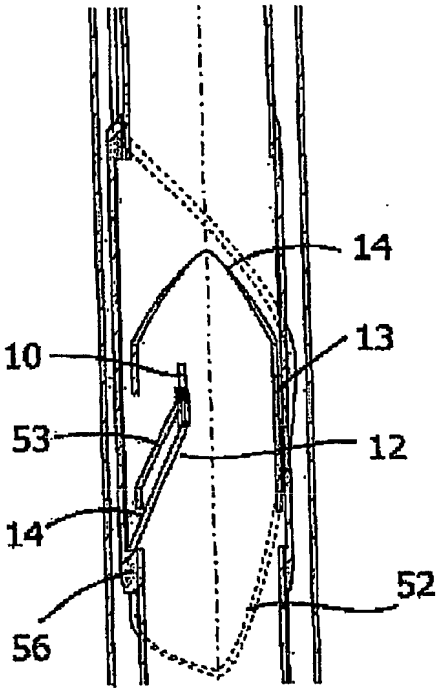


fig 2



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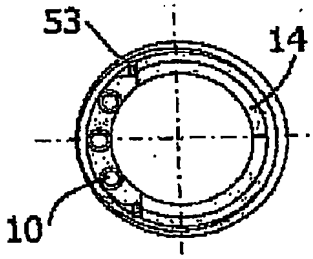

fig 4

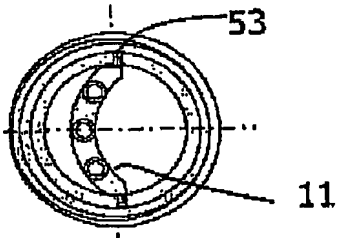

fig 5

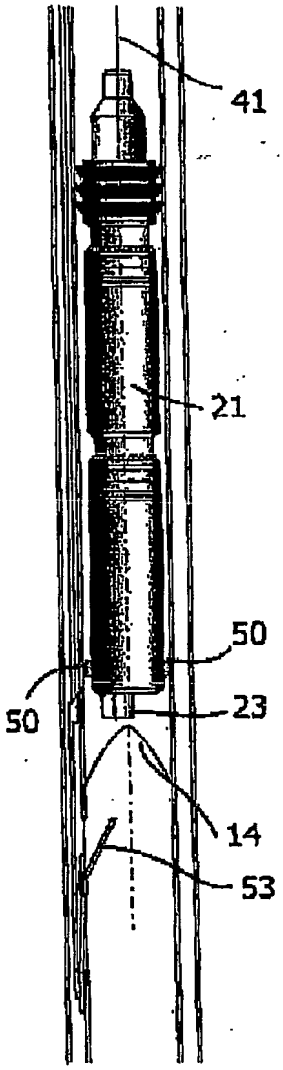

fig 6

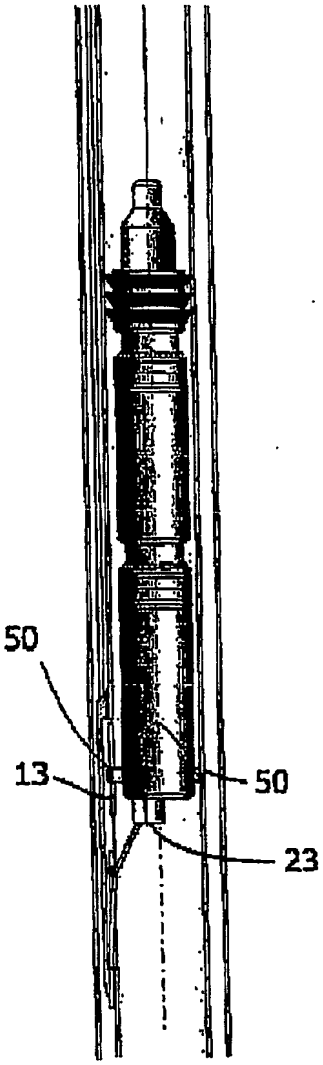

fig 7

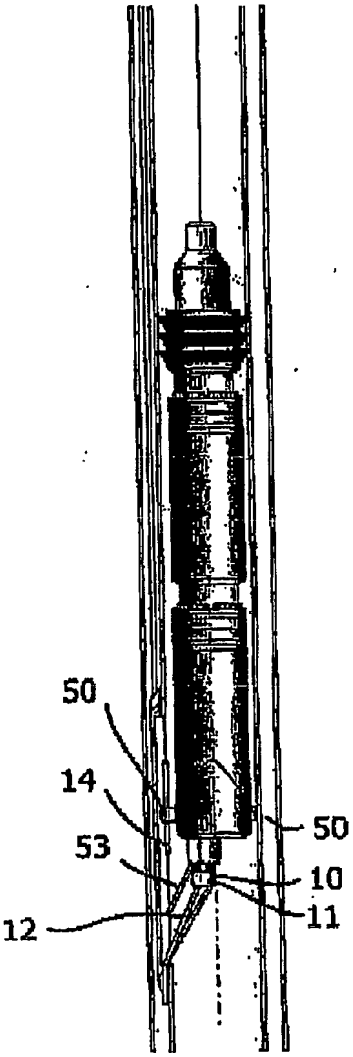

fig 8

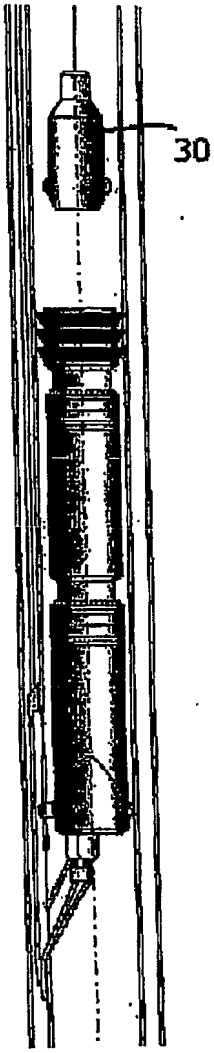

fig 9